PATENT SPECIFICATION (11) 1 347 184

1 347 184

(21) Application No. 31891/72 (22) Filed 7 July 1972

(61) Patent of Addition to No. 1 329 081 Dated 27 Aug. 1970

(44) Complete Specification published 20 Feb. 1974

(51) International Classification C23B 5/68//5/06 5/08 5/18 5/32 5/62 5/64 7/00

(52) Index at acceptance C7B 15A 1B 1E 1Q 1R 1S A2G A3 A4

(72) Inventors ERIC CHARLES KEDWARD
JAMES GRAHAM MARTIN

(19)

(54) ELECTRODEPOSITION OF COMPOSITE COATINGS

(71) We, BRISTOL AEROJET LIMITED, a Company registered under the Laws of Great Britain, of Banwell, Weston-Super-Mare, Somerset, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus and processes for producing composite coatings which consist of an electrolytically deposited metal matrix with particle additions, the metal and the particles being deposited from an electrolyte in which the particles are substantially insoluble. Such a process will be referred to as the electrodeposition of composite coatings. The particles may be, for example, ceramic, cermet, or laminar solids. The invention is primarily concerned with the electrodeposition of coatings incorporating ceramic particles. Such coatings may be used for various purposes including wear and abrasion resistance, corrosion and oxidation resistance and improvement in the coefficient of friction (lubricity) and anti-fretting and anti-galling properties. In certain cases the coatings themselves may constitute the final product so that the process is one of electroforming.

The process comprises electroplating in a bath containing insoluble particles dispersed in the electrolyte, the particles being co-deposited with the metal.

The invention is an improvement in or a modification of the invention (the main invention) described and claimed in our co-pending application No. 28191/69 (Serial No. 1 392 081). That application claims apparatus for the electrodeposition of composite coatings consisting of a metal matrix with particulate additions, the apparatus including a container for the electrolyte and the particles, an electrode in the container, an electrical connection to the electrode, a generally horizontal perforated agitator in a region adjacent the bottom of the container, and means for reciprocating the agitator in a vertical direction. That application also claims a method of producing composite coatings consisting of a metal matrix with particulate additions, in which method electrolytic deposition of metal takes place in a solution which contains insoluble particles, the solution being agitated by movement generally up and down of a generally horizontal perforated agitator in the part of the solution below and spaced from the part used for deposition.

The agitator may take the form of a perforated plate and the effect of moving a perforated plate up and down in the lower part of the solution is to force the solution through the perforations both on the upward and the downward strokes so that a vigorous agitation of the solution is obtained.

The proportion of the part of the solution swept by the moving plate relative to the part above the plate which forms the useful part in which plating can be carried out will depend upon many factors including the size of the container and the sizes of the particles to be maintained in suspension, the frequency of movement of the plate, the size and distribution of the holes in the plate, the size of the clearance between the plate and the walls of the container and other factors but preferably the plate sweeps approximately the bottom third of the solution.

While the reciprocation of the perforated plate maintains the slurry in a sufficiently homogeneous condition for many plating situations, it has been found that when plating some articles, for example, articles having bores, the reciprocation of the plate will not always maintain the slurry in a sufficiently homogenous condition in the bores of the article. Thus the solution becomes static and a shortage of ions and

particles in the region of the article may arise.

According to the present invention, apparatus as claimed in the main invention includes means for admitting gas to the container adjacent the bottom of the container.

The gas which is admitted to the container produces a generally upward flow of gas in the region in which deposition takes place and this tends to break up the static boundary layer of solution adjacent the article being plated which may arise in the plating situations discussed above and will tend to maintain the solution homogenous throughout the solution.

Preferably the agitator is in the form of a plate extending across a major part of the cross-section of the container. In this case, the means for admitting gas may include means for distributing gas to a number of discharge openings carried by the plate. For example, the distribution means may comprise one or more tubes fixed to the upper surface of the plate, the tubes having perforations in their upper side walls facing the top of the container to permit gas to flow upwardly from the tubes through the plating solution.

According to a further aspect of the present invention, in a method of producing composite coatings consisting of a metal matrix with particulate additions, electrolytic deposition of metal takes place in a solution which contains insoluble particles, the solution being agitated by movement generally up and down of a generally horizontal perforated agitator in a part of the solution below and spaced from the part used for deposition, gas being admitted to the solution to produce a generally upward flow of gas in the region in which deposition takes place.

The invention may be carried into practice in various ways but one way of carrying out the invention will now be described by way of example with reference to the accompanying drawings, of which:—

Figure 1 is a side elevation of an apparatus suitable for carrying out the process but omitting the air admission pipes;

Figure 2 is a fragmentary section on the line II-II of Figure 1 showing the tank and agitator plate, and

Figure 3 is a section on the line III-III of Figure 2.

The apparatus shown in Figure 1 comprises a rectangular tank 1 containing a bath of a slurry of plating solution 2 and particles which are to be codeposited. In the tank 1 there is a plate agitator 3 extending across substantially the whole cross-section of the tank and having perforations 5 (Figure 2) through it. The perforations have bevelled edges which may form an angle of about 45° with the upper surface of the plate; the edges may be bevelled so that the hole in the upper surface of the plate is smaller than in the lower surface.

As can be seen from Figures 2 and 3 the plate 3 has a number of strengthening bars 31 of T-section extending parallel with its two shorter sides. A similar strengthening bar 32 extends along the centre of the plate parallel with the longer sides of the plate. A stainless steel pipe 33 is situated between and parallel with each pair of bars 31. Each pipe has perforations 34 in its side wall arranged so that all the perforations face the top of the plating solution. The pipes 33 are connected to one another by a further pipe 35 which lies along the bar 32. One end of this pipe is connected by a flexible pipe (not shown) to a supply of compressed air outside the bath. The pipe is flexible to permit the plate to reciprocate freely.

At the central point 4 of each of two opposite sides the plate agitator is attached to one arm 6 of an inverted U-shaped member 7, one arm 6 of which is within the tank and the other arm 8 is outside the tank. The inverted U-shaped members 7 are arranged to reciprocate in a vertical direction so as to reciprocate the perforated agitator plate 3 in the region adjacent the bottom of the container between the position shown in dotted lines in Figure 1 and a position below the area in which deposition takes place. The distance moved by the agitator plate is conveniently about 1/3 the depth of the bath. The U-shaped members 7 are guided in backets 11 situated outside the tank and rigidly attached to a cylinder 12. Attached to the arm 8 of the U-shaped member 7 is a yoke 13 which is also attached to a piston rod 14 of a piston 15 which reciprocates within the cylinder 12. Reciprocation of the piston and piston rod, therefore, causes the U-shaped member and the agitator plate to reciprocate.

The movement of the piston is controlled by means which are not shown. The cylinder 12 is supported on a base plate 20 by a support member having three legs of which only two 20a and 20b, are shown.

It is important that both sides of the plate reciprocate in phase and for this purpose the yoke 13 is attached to an endless chain 16 which passes over an upper sprocket wheel 17 mounted on a shaft 18 situated at the top of the cylinder 12 and around a lower sprocket wheel 19 which is rigidly attached to a connecting member 21. Movement of the piston and piston rod will cause the chain to move the sprocket wheel 19 and rod 21. As the rod 21 carries the sprocket wheels 19 for both sides of the apparatus the movement of the pistons and therefore of the sides of the reciprocating agitator is kept in synchronism.

An anode 22 dips into the solution 2 adjacent one side wall of the tank and the components to be coated are suspended adjacent the centre of the bath as the cathode. The anode and the cathode are connected to an electricity supply via control equipment of the kind normally employed for plating.

The process is carried out as follows. When plating is to take place, reciprocation of the plate 3 by the pistons is begun, and air from the air supply passes through the pipe 35 to the holes 34 in the pipes 33. Thus the plate sweeps approximately the bottom third of the bath which produces vigorous agitation of the solution as it is forced through the perforations 5 and the narrow clearances between the edges of the plate and the walls of the bath. The particles are, therefore, taken into suspension. When the solution has been agitated for a sufficient time for it to be become homogeneous the components to be plated are loaded into the bath and the plating current is switched on and plating proceeds in the normal way. Reciprocation of the plate 3 is continued throughout the plating operation to maintain the homogeneity of the solution.

The apparatus may be used for deposition of many different composite coatings examples of which include nickel, cobalt, copper, chromium and tungsten-cobalt alloy as the metal matrix and zirconium diboride and tungsten carbide as the insoluble particles. The composite coatings may incorporate a solid lubricant for cases where the coating is to act as a bearing using the term broadly to cover any relative movement between adjacent surfaces between which a load is transmitted. For example, graphite particles may be incorporated in the coating to provide a three-component coating of metal matrix, ceramic particles and graphite particles.

Plating may take place on any substrate which can be plated including, for example, steel, non-ferrous and light alloy components and plastics, glass and composite materials where such materials have been rendered conductive either by incorporation of appropriate materials or by pre-coating with a conductive material.

WHAT WE CLAIM IS:—

1. Apparatus for the electrodeposition of composite coatings consisting of a metal matrix with particulate additions, the apparatus including a container for the electrolyte and the particles, an electrode in the container, an electrical connection to the electrode, a generally horizontal perforated agitator in a region adjacent the bottom of the container, means for reciprocating the agitator in a vertical direction, and means for admitting gas to the container adjacent the bottom of the container.

2. Apparatus as claimed in Claim 1 in which the agitator is in the form of a plate extending across a major part of the cross-section of the container.

3. Apparatus as claimed in Claim 2 in which the means for admitting gas includes means for distributing gas to a number of discharge openings carried by the plate.

4. Apparatus as claimed in Claim 3 in which the distribution means comprises one or more perforated tubes fixed to the plate.

5. Apparatus as claimed in Claim 5 in which the tube or tubes are perforated in that surface which faces the top of the container.

6. Apparatus as claimed in Claim 4 or Claim 5 in which the tube or tubes are connected to a source of pressurised gas by means of a flexible pipe.

7. Apparatus for the electrodeposition of composite coatings substantially as described herein with reference to the accompanying drawings.

8. A method of producing composite coatings consisting of a metal matrix with particulate additions, in which method electrolytic deposition of metal takes place in a solution which contains insoluble particles, the solution being agitated by movement generally up and down of a generally horizontal perforated agitator in the part of the solution below and spaced from the part used for deposition, gas being admitted to the solution to produce a generally upward flow of gas in the region in which deposition takes place.

9. A method as claimed in Claim 8 in which the outlet for gas is arranged to move with the agitator.

10. A method for the electrodeposition of composite coatings substantially as described herein with reference to the accompanying drawings.

KILBURN & STRODE
Chartered Patent Agents
Agents for the Applicants

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1974.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1347184 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

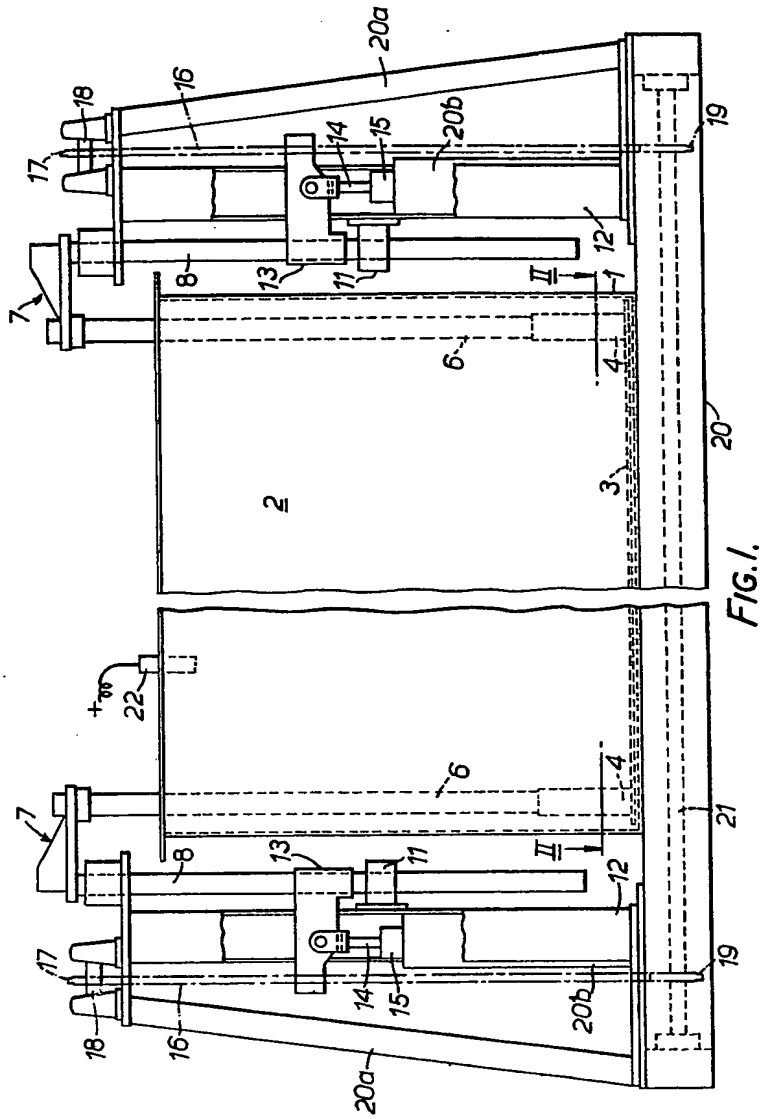

FIG. 1.

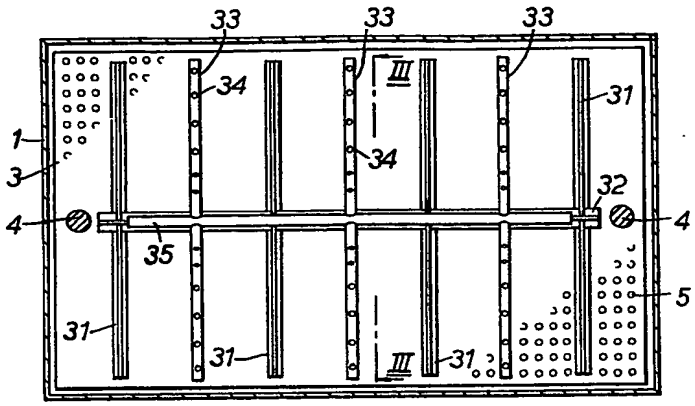

FIG. 2.

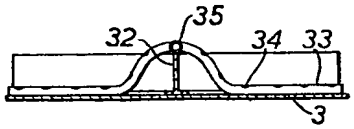

FIG. 3.